

STEVEN L. BESHEAR
GOVERNOR



LEONARD K. PETERS
SECRETARY

ENERGY AND ENVIRONMENT CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION
DIVISION OF WATER
200 FAIR OAKS LANE, 4TH FLOOR
FRANKFORT KENTUCKY 40601
www.kentucky.gov

September 5, 2013

City of Frankfort
Attn: William Scalf, Dir. Frankfort Sewer Dept.
315 West 2nd Street
Frankfort, KY 40601

RE: City of Frankfort
Alt. C, EQ Basin

Dear Mr. Scalf:

Thank you for submitting the required documentation for a Green Project Reserve Business Case for the EQ Basin project, funded through the CWSRF program. A provision of the 2012 CWSRF capitalization grant requires that to the extent there are eligible project applications; states shall use 20% of its Clean Water State Revolving Fund capitalization grant for green infrastructure projects. These projects are intended to address water and energy efficiency improvements or other environmentally innovative activities. The Kentucky Division of Water (KY DOW) has reviewed the business case for the above mentioned project and found the justification to be acceptable, with approved green components totaling \$9,500,000. If the scope of the project is altered in any way to exclude the GPR eligible components, the City of Frankfort shall submit the changes in writing to the KY DOW and receive prior approval in writing before proceeding with construction.

We look forward to working with you in finalizing your wastewater infrastructure project. If you have any questions regarding this correspondence, please contact me at (502) 564-3410, ext 4832.

Sincerely,

A handwritten signature in cursive script, appearing to read "Greg Goode".

Greg Goode, P.E.
Water Infrastructure Branch
Division of Water

**Clean Water State Revolving Fund
Green Project Reserve Business Case**

**City of Frankfort Sewer Department
Wet Weather Detention Facilities
KIA No.: A13-011
CWSRF No.: CWL13017**

August 7, 2013

Environmentally Innovative

Summary

- Project Components:
 - One (1) 10 million gallon concrete basin Wet Weather Detention Facility (WWDF), approximately 185' in diameter and 50' in height
 - Wet Weather Pumping Station (WWPS)
 - Tri-Plex Submersible Pumps (2 duty, 1 standby)
 - 140 hp
 - Max capacity of 20 MGD @ 92' TDH
 - VFD equipped
 - 30" force main from WWPS to WWDF
 - 24" emergency overflow piping
- CWSRF loan amount = \$8 million
- Estimated project cost = \$9.5 million
- Estimated Cost of Environmentally Innovative Components:
 - EQ Basin Project \$8,900,000 (111% of loan amount)

Background

- The City of Frankfort, KY is under a Consent Judgment from the Kentucky Division of Enforcement centering upon improvement of water quality in area waterways via elimination of sewer overflows.
- The City's wastewater treatment plant (WWTP) is rated to treat an average daily flow of 9.9 million gallons per day (MGD) and a peak daily flow of 24 MGD.
- Flow from the City's combined sewers can exceed 24 MGD during significant rain events.
 - Current operational practice during such events is to trim back and/or shut down certain pump stations and allow the flow to back up in the collection system and/or overflow at permitted combined sewer overflow (CSO) locations.
- Existing WWTP experiences hydraulic constraints at flows in excess of 18 MGD
- The WWDF are designed to relieve combined sewer flow to the WWTP during significant rain events as a collection facility adjacent to the WWTP with controlled discharge to the WWTP as capacity becomes available.

Results

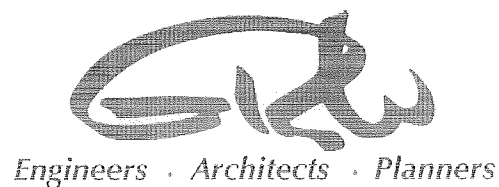
- The City of Frankfort has performed numerous feasibility studies and hydraulic analyses on the existing collection system, including a recent Long Term Control Plan.
- One option evaluated in various studies is the upgrade and rehabilitation of the entire collection system, along with separation of all combined sewers immediately. Obviously, such a project is not feasible in terms of financial impacts and logistics and was found to be infeasible.
- A second option is an upgrade and expansion of the existing WWTP to 20 MGD capacity. With an estimated cost of approximately \$40 million, this option was rejected due to cost.
- A third option is the construction of Wet Weather Detention Facilities. This option allows the existing WWTP to operate within its current capacity and offers storage of wet weather sewer flows, which can mitigate overflows within the collection system and, in extreme circumstances, bypasses at the WWTP. The construction of a 10 million gallon wet weather detention facility is estimated to cost a total of \$9.5 million.

Benefits

- The construction of a 10 million gallon wet weather detention facility was selected as the most feasible option by the City.
- This option is the least costly in terms of immediate capital investment.
- This option can be implemented and placed into beneficial use in a shorter timeframe than the other options considered.
- Implementation of the WWDF option allows for the costs of collection system upgrades and rehabilitation to be incurred over a longer period of time, thereby reducing the immediate financial burden of such projects on the City.

Conclusion

- The capital investment of the WWDF option is estimated to be \$9.5 million versus the estimated \$40 million cost of a WWTP expansion. This represents an immediate savings of over \$30 million, which is in addition to the lower operation and maintenance cost of the WWDF versus any WWTP.
- The WWDF solution is by far the most cost-effective means Frankfort has studied to deal with wet weather sewer flows.



**Clean Water State Revolving Fund
Green Project Reserve Business Case**

**City of Frankfort Sewer Department
Wet Weather Detention Facilities
KIA No.: A13-011
CWSRF No.: CWL13017**

August 14, 2013

Energy Efficiency

Summary

- Project Components:
 - One (1) 10 million gallon concrete basin Wet Weather Detention Facility (WWDF), approximately 185' in diameter and 50' in height
 - Wet Weather Pumping Station (WWPS)
 - Tri-Plex Submersible Pumps (2 duty, 1 standby)
 - 140 hp
 - Max capacity of 20 MGD @ 92' TDH
 - VFD equipped
 - Premium efficiency motors equipped.
 - 30" force main from WWPS to WWDF
 - 24" emergency overflow piping
- CWSRF loan amount = \$8 million
- Estimated project cost = \$9.5 million
- Estimated Construction Cost of Energy Efficiency Components:
 - VFD pump controllers - \$60,000 (0.75% of loan amount)
 - Premium efficiency motors for pumps - \$150,000 (1.9% of loan amount)
 - SCADA system - \$100,000 (1.25% of loan amount)

Background

- The City of Frankfort, KY is under a Consent Judgment from the Kentucky Division of Enforcement centering upon improvement of water quality in area waterways via elimination of sewer overflows.
- The City's wastewater treatment plant (WWTP) is rated to treat an average daily flow of 9.9 million gallons per day (MGD) and a peak daily flow of 23 MGD.
- Flow from the City's combined sewers can exceed 23 MGD during significant rain events.
 - Current operational practice during such events is to trim back and/or shut down certain pump stations and allow the flow to back up in the collection system and/or overflow at permitted combined sewer overflow (CSO) locations.
- The WWDF are designed to relieve combined sewer flow to the WWTP during significant rain events as a collection facility adjacent to the WWTP with controlled discharge to the WWTP as capacity becomes available.

Results

- Premium Efficiency Motors for Pumps
 - Premium efficiency motors are provided with the pumps, which are more efficient than standard motors.
 - Standard pumps typically have an average hydraulic efficiency 70%.
 - Standard motors typically have an average efficiency of 90%.
 - The wire to water efficiency of standard pumps is equal to the product of the pump hydraulic efficiency and the motor efficiency and can be calculated as follows:
Efficiency = 70% x 90% = 63%
 - The pumps provided have a hydraulic efficiency of 81%.
 - The premium efficiency motors have an efficiency of 95%
 - The wire to water efficiency of the premium efficiency motors and pumps can be calculated as follows:
Efficiency = 81% x 95% = 77%
 - The increase in wire to water efficiency is 22% ($95\%/81\% = 1.22$), thus exceeding the minimum goal of 20%.
- Variable Frequency Drives
 - Variable Frequency Drives (VFDs) control the frequency of electrical power supplied to a motor, thus saving energy by matching system demands. This is due to the fact that the torque varies roughly with the square of the speed, while horsepower required varies roughly with the cube of the speed, resulting in a large horsepower reduction for even a small reduction in speed. Combined with supervisory control and data acquisition (SCADA) systems, this can result in cost savings of thousands of dollars per year. For example, reducing the motor speed by 20% can reduce the input power requirements by approximately 50% and can be calculated as follows:

$$\begin{aligned} \text{HP}_2 &= \text{HP}_1 \times (\text{RPM}_2/\text{RPM}_1)^3 \\ &= 140 \text{ HP} \times (952 \text{ RPM}/1190 \text{ RPM})^3 \\ &= 72 \text{ HP} \end{aligned}$$

Benefits

- The SCADA system integrates sewer flow data from a meter installed within an overflow structure constructed outside this project and the VFD's being installed on the pumps and motors in the WWPS, as well as controls a modulating gate and valve to control sewer flows into the WWTP and WWPS.
- Doing so eliminates the need for City personnel to manually operate the overflow structure, WWPS and WWDF. This allows valuable and limited manpower resources to be allocated to other much needed tasks during a wet weather event, thereby reducing overall labor costs by lowering required overtime, etc. associated with emergency type situations.
- Premium efficiency motors are more efficient than standard motors, thus reducing electrical energy consumption.
- VFD's can allow the pump motor speed to reduce to match the flow, thus significantly reducing electrical energy consumption.

Conclusions

- The SCADA system integrates sewer flow data from a meter installed within an overflow structure constructed outside this project and the VFD's being installed on the pumps and motors in the WWPS, as well as controls a modulating gate and valve to control sewer flows into the WWTP and WWPS.
- Assuming the pumps are used 12 times per year and an operating time of 24 hours per frequency, the premium efficiency motor for one pump can save approximately \$695 annually and can be calculated as follows:

Standard Motors

$$\begin{aligned}\text{kW/year/pump} &= (140 \text{ HP}/0.63) \times (0.746 \text{ kW/HP}) \times 24 \text{ hours/day} \times 12 \text{ days/year} \\ &= 47,744 \text{ kW-hour/year/pump}\end{aligned}$$

$$\text{Electrical cost/year/pump} = 47,744 \text{ kW-hour/year/pump} \times \$0.08/\text{kW-hour} = \$3,820/\text{year/pump}$$

Premium Efficiency Motors

$$\begin{aligned}\text{kW/year/pump} &= (140 \text{ HP}/0.77) \times (0.746 \text{ kW/HP}) \times 24 \text{ hours/day} \times 12 \text{ days/year} \\ &= 39,063 \text{ kW-hour/year/pump}\end{aligned}$$

$$\text{Electrical cost/year/pump} = 39,063 \text{ kW-hour/year/pump} \times \$0.08/\text{kW-hour} = \$3,125/\text{year/pump}$$

$$\begin{aligned}\text{Annual Savings} &= \$3,820/\text{year/pump} - \$3,125/\text{year/pump} \\ &= \$696/\text{year pump}\end{aligned}$$

- Assuming the pumps are used 12 times per year, an operating time of 24 hours per frequency, and the speed of the motors is reduced by 20% for 25% of the time while operating, the VFD for one pump can save approximately \$2,723 annually and can be calculated as follows:

$$\begin{aligned}\text{kW/year/pump} &= (72 \text{ HP}/0.77) \times (0.746 \text{ kW/HP}) \times 24 \text{ hours/day} \times 12 \text{ days/year} \times 0.25 \\ &= 5,022 \text{ kW-hour/year/pump}\end{aligned}$$

Note: 72 HP shown was calculated earlier by reducing the speed of the motor by 20%.

$$\begin{aligned}\text{Electrical cost/year/pump} &= 5,022 \text{ kW-hour/year} \times \$0.08/\text{kW-hour} \\ &= \$402/\text{year/pump}\end{aligned}$$

As shown earlier, the electrical cost/year/pump without a VFD is \$3,125. Therefore, an annual savings of approximately \$2,723/year/pump can be realized by using VFDs and can be calculated as follows:

$$\begin{aligned}\text{Annual Savings} &= \$3,125/\text{year/pump} - \$402/\text{year/pump} \\ &= \$2,723/\text{year/pump}\end{aligned}$$

